NAVAL SURFACE WARFARE CENTER
Bounded to the south by the Clara
Barton Parkway and to the north and
east by MacArthur Boulevard
~~Bethesda vicinity~~ Silver Spring
Montgomery County
Maryland

HAER No. MD-118

HAER
MD,
16-SILSPR,
3-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, P.A. 19106

HAER MD, 16-SILSPR, 3-

HISTORIC AMERICAN ENGINEERING RECORD

NAVAL SURFACE WARFARE CENTER

HAER No. MD-118

Location: Bounded to the south by the Clara Barton Parkway and to the north and east by MacArthur Boulevard
~~Bethesda Vicinity~~ Silver Spring
Montgomery County
Maryland

USGS Falls Church, Virginia Quadrangle
Universal Transverse Mercator Coordinates:
18.310970.4316440
18.310970.4315700
18.309020.4315700
18.309020.4316440

Date of Construction: 1938-1996

Engineer: Bureau of Yards and Docks, Navy Department
Architect: Bureau of Yards and Docks, Navy Department

Present Owner: U.S. Department of Navy
Department of Defense

Present Use: Naval Surface Warfare Center Carderock Division (NSWCCD)

Significance: Naval Surface Warfare Center Carderock Division (NSWCCD) is associated with events that have made a significant contribution to the broad patterns of military technology. The resources represent an intact collection of research, design, testing, and evaluation (RDT&E) buildings and facilities. As the center for naval RDT&E, NSWCCD played a critical role in the design and development of the modern navy. The research facilities at NSWC have provided the U.S. Navy with accurate cost effective data on air and sea vehicle performance, and have made possible evaluative changes to improve performance, in advance of construction.

Project information: Under the 1995 round of Base Closure and Realignment (BRAC), research functions carried out at Naval Surface Warfare Center White Oak, Maryland will be relocated to Naval Surface Warfare Center Carderock Division. Three of the original buildings, the Subsonic Wind Tunnel Building, the Transonic Wind Tunnel Building, and the Supersonic Wind Tunnel Building will be altered to accommodate these new functions. Documentation of these three buildings to the standards of the Historic American Engineering Record prior to alteration was prescribed as a stipulation of a Memorandum of Agreement negotiated among the Maryland State Historic Preservation Officer and the Department of the Navy, and accepted by the Advisory Council on Historic Preservation. This documentation was undertaken in June and July 1995 in partial fulfillment of that agreement.

Geoffrey Eden Melhuish
Assistant Project Manager
R. Christopher Goodwin & Associates, Inc.
337 East Third Street
Frederick, Maryland 21701

Introduction

Naval Surface Warfare Center (NSWC) Carderock Division is a 116-buildings naval research, design, testing, and evaluation complex occupying a 183.6 acre tract of land in the Potomac River Valley, in the vicinity of Bethesda, Maryland. NSWC is located approximately 12 miles northwest of Washington, D.C., along the northern bank of the Potomac River. The installation is bordered to the south by the Clara Barton Parkway and to the north and east by MacArthur Boulevard. Initial construction of NSWC began in 1938. New buildings have been erected and existing buildings modified or replaced as needed. Buildings presently occupying NSWC date from 1938 to 1996.

Research laboratories, administration facilities, and operations and utility structures are the main components of the installation. The overall facility achieves architectural unity through its integrated layout and building design. The overall installation plan create an institutional image of durability and orderliness. In general, the buildings are in good condition and have undergone few alterations. Common alterations include modern replacement windows and entry units.

The center of the installation is occupied by an interconnected model basin complex that includes an administration building, a shop building, a laboratory and the David Taylor Model Basin (DTMB). The DTMB is a model testing facility used to determine the most desirable shapes for naval vessels. The DTMB originally extended 1300 feet in length and was oriented parallel to the other three complex structures. The model basin was extended in 1946 to its present length of 3,200 feet to accommodate tests and the increase in ships size and speed.

The Model Basin was listed in the National Register of Historic Places in 1985 for its association with the development of the modern navy and its unique scientific facilities.[1] The David Taylor Model Basin houses three separate towing facilities, which are designed to facilitate testing in a variety of areas, including hull resistance, self-propulsion, and flow measurement experiments. The three towing facilities are the Shallow Water Basin, used to test tugboats and barges; a Deep Water Basin, for large models; and a High Speed Basin. The High Speed Basin, used to test motorboats, patrol boats, and similar crafts, is comprised of a deep water section and a shallow water section. Wavemaking capabilities exists in this basin. Each towing facility contains its own carriage for towing models. To achieve uniform carriage speed and accurate results, the carriage tracks were laid parallel to the curvature of the earth.

The majority of buildings and facilities added to the installation after the initial construction of the model basin complex were constructed to house new research programs assigned to the installation. Additional areas assigned to the installation were underwater explosive testing, aeronautical research, and hydrodynamical research.

The first research laboratory constructed after the model basin was the research pit for underwater explosion testing. Constructed in 1941, the research pit is an underground metal tank incorporating a three-leg, metal-frame derrick. This structure was built to study the deformation of naval ship diaphragms due to underwater explosions and the effect of gun blast on water-tight doors.

In 1943, an instrument house and a test pond were constructed to the research pit. The primary use of the test pond was to perform underwater tests to simulate the effects of underwater blasts from mines and other explosive devices, such as small charges of TNT. In the early Cold War Era model tests on the effects of nuclear weapons were completed in the test pond prior to full-scale testing in the Pacific.

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[1] David K. Allison, "National Register of Historic Places Nomination Form, David Taylor Model Basin" (MSS, National Park Service, National Register on Historic Places, Washington, D.C., 1984).

In 1944, the Circulating Water Channel was constructed to test the angle and drag of underwater towed devices and to observe water flow around underwater appendages such as thrusters, struts, rudders, and diving planes. While some of these tests could be carried on in an open model basin, windows located below the water surface of the Circulating Water Channel simplified photography and observation procedures.

The Wind Tunnel Complex at NSWC Carderock Division was established in 1943 to augment the Navy's aeronautical research program. Designed by the Bureau of Yards and Docks, the first wind tunnel complex and Aeronautical Laboratory at NSWC was comprised of a laboratory (Building 7) and two subsonic wind tunnels (Buildings 138 and 139). Located southwest of the model basin, the Subsonic Wind Tunnel Building was designed to test and to analyze scale airplane models with wing spans as wide as eight feet. By using fans to force air through the tunnels, the laboratory was able to test models at speeds up to 180 miles per hour. Much of the initial work load of the facility was directed toward obtaining quick, practical answers to questions on the development and operation of naval aircraft.

The subsonic wind tunnels are classified as the closed throat, single return type with vented sections. Air was forced through the tunnel and test section by a large fan connected to a powerful motor. Slots on the downstream side of the test section allow the air to transfer between the wind tunnel and the outside environment. This vented section maintained equal pressure between the wind tunnel and the outside environment. The wind tunnel was a water cooled system. Water was sprayed down the sides of the tunnel to control the increased temperatures within the tunnel. The evaporation of the water cooled the structure.

Soon after the construction of the Subsonic Wind Tunnel Building, the introduction of the jet engine greatly increased the operational speeds of aircraft; more specialized facilities were needed to address questions related to increased performance. Funds were approved in 1946 for the construction of a Supersonic Wind Tunnel Building (Building 11) to house supersonic wind tunnels and the ancillary equipment. The construction of the Supersonic Wind Tunnel Building began soon after. Located southwest of the Subsonic Wind Tunnel Building, the supersonic wind tunnels were a developmental test facility for determining the stability and control characteristics of either complete scale models or the components of aircraft and missiles.

Unlike the subsonic wind tunnels, the supersonic wind tunnels were blow-down wind tunnels. Each supersonic wind tunnel was connected to a common vacuum sphere. Before a test, the sphere was emptied by a Chicago Pneumatic air pump located in Building 11. A small valve was then opened and air rushed through the test chamber and into the sphere at great speed. In order to vary the mach number, the throat of the test chamber was adjusted. The narrower the throat, the higher the mach number.

While NSWCCD was adding the supersonic wind tunnels to its testing complex, the installation acquired a large transonic wind tunnel from Ottobrun, Germany. Construction began in February 1949 on the Electrical Equipment Building (Building 12) to house the wind tunnel machinery. Located west of the Subsonic Wind Tunnel Building and north of the Supersonic Wind Tunnel Building, this facility, the Transonic Wind Tunnel Building was completed by 1956. Initially, the German built three-meter wind tunnel was used for sonic testing; modifications to the wind tunnel design allowed for this facility to include transonic capabilities as well.

The transonic wind tunnel was a closed circuit, single return type, similar in basic design to the subsonic wind tunnels. However, the test section of the Transonic Wind Tunnel was enclosed within a pressure tight slotted chamber. This chamber allowed the tunnel to be evacuated to a maximum of 700 pounds per square foot with the help of the Chicago pneumatic pumps located in the Supersonic Wind Tunnel Building. Two counter-rotating fans driven by twin 12,000 horsepower motors then forced air through

the test section. The slots within the test section controlled the air flow through the section and thus the speed. The temperature within the tunnel was controlled by an internal radiator combined with an evaporation cooling tower (Building 158).

The Wind Tunnel Complex is an integral part of the larger naval test complex at NSWCCD. Located within the current boundaries of NSWCCD, the Wind Tunnel Complex is a distinct development area located southwest of the David Taylor Model Basin. Between 1943 and 1959, the complex's permanent structures were constructed within this area as needs dictated and funding allowed. Current plans call for alterations of the Wind Tunnel complex to accommodate the relocation of Naval Surface Warfare Center White Oak.

Historic Context

Development of Naval RDT&E Facilities

The U.S. Navy's first laboratory for studying ship behavior was the United States Experimental Model Basin (EMB). The model basin was constructed in 1898, under the direction of Rear Admiral David Watson Taylor, USN, at the Washington Navy Yard[2]. The test facility included a carriage to tow and photograph wooden ship models so that engineers could study how eddy and wave making resistance were generated.[3] The basin was 14 feet deep, 42 feet wide and 470 feet long.

The most notable work performed at the EMB was the invention of the bulbous ship bow. This new design greatly reduced the bow wave common to older vessels and allowed for more efficient engine utilization. Experiments completed at the EMB included propeller and rudder studies, in addition to routine testing of ship's hulls. Overall, the design of over 1000 ships was influenced by the work done at the EMB.[4]

While intensive research into ship construction and performance continued at the Model Basin, advancements in aviation stimulated interest in the naval applications of flight. Admiral Taylor, an expert in naval engineering, became strong supporter of the study of aerodynamics and of the need for a wind tunnel to conduct testing into the field.

In 1912, Admiral Taylor, assisted by aeronautical engineers, Holden C. Richardson and William W.McEntree, designed the Navy's first wind tunnel.[5] Construction began in 1913, and, by December 1914, the Navy's first wind tunnel was placed in operation. The 8x8 foot wind tunnel constructed at the

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[2] For a complete history of David W. Taylor see David K. Allison, Ben G. Keppel, and C. Elizabeth Nowicke, *David W. Taylor* (Government Printing Office, Washington, D.C., 1988).

[3] Virginia Conn, *David Taylor Model Basin, A Brief History,* Naval Historical Publication (Washington, D.C.: Naval Historical Foundation, Washington Navy Yard, 1971), 6.

[4] Navy Department, "David Taylor Model Basin History," (1959) *United States Naval Administration Histories of World War II,* Naval Historical Foundation, Washington Navy Yard, Washington, D.C.

[5] This was not the first wind tunnel built. In 1871, a steam powered tunnel, 18 inches square and capable of winds up to 40 miles per hour was built in England. By 1903, there were thirteen wind tunnels in the world, two of which were located in the United States.

Washington Navy Yard was made of wood; the tunnel could accommodate tests reaching a velocity of 54 miles per hour in the test section.[6] The wind tunnel tested the resistance of shapes in air. Accurate predictions and the effects of the force of air were made by the control and measurement of air speed around the models. One revolutionary feature of the structure was its closed circuit design.

By 1918, the tests scheduled for the wind tunnel were so numerous that another, smaller tunnel was constructed. With a cross section of four square feet and a maximum speed of 45 miles an hour, the second tunnel was used in experiments on air foils and small models. By the end of 1918, the wind tunnels operated sixteen hours a day. Much of the work performed in the wind tunnels involved improving the aerodynamics of airfoils, body shapes, and windshield design.[7]

As the science of ship and aircraft model testing evolved; the facilities at the Experimental Model Basin became inadequate. Higher ship speeds demanded faster carriage runs, but with the facility's restricted space, the carriage could only run for a few seconds. Increased ship size led to larger scale models. Tests on these larger models suffered from errors due to the small size of the testing basin. In addition, the building housing the basin was settling due to its river bank site. As a result, the carriage tracks had sunk five and a half inches, making sensitive tests extremely difficult. In May 1936, Congress authorized the development of a new facility and appropriated $3,500,000 for land acquisition and construction.

The Bureau of Construction and Repairs, who would operate the new facility, established criteria for the design and location of the new model basin. The list of requirements were furnished to the Bureau of Yards and Docks, Department of the Navy. These requirements included easy access to the Navy offices in Washington, space for expansion, a fresh water supply for filling the basins, and bedrock to support the basin wall and carriage track foundations.[8]

Under the leadership of Commander Ben Morell, the Bureau of Yards and Docks developed architectural plans that included designs for a long rectangular basin building. The basin building was covered by a concrete barrel arch roof with hinged sections to allow for expansion and contraction.[9] A three story office, a laboratory, and a shop building were connected to the basin building.

Establishment of Carderock

Naval Surface Warfare Center Carderock Division.

After an intensive search, a site was selected in Carderock, Maryland, which satisfied the Bureau's

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[8] For a complete history of the Washington Navy Yard Wind Tunnel see Norman J. Fresh, *The Aerodynamics Laboratory (The First 50 Years)* Aero Report 1070. (Bethesda: Naval Surface Warfare Center, 1964), 11.

[7] Rodney Carlisle, *Where the Fleet Begins: A History of the David Taylor Research Center* (Bethesda: Naval Surface Warfare Center, 1987), 4-18.

[8] Allison, *D. W. Taylor*, 107.

[9] Carlisle, *Where the Fleet Begins: A History of the David Taylor Research Center*, 5-8.

criteria; construction began on September 8, 1937 by Turner Construction Company, New York and was completed in less than two years later.[10] On 4 November 1940, the David Taylor Model Basin (DTMB) was dedicated in honor of Rear Admiral David W. Taylor. At that time, the primary mission, as defined by Congress, was to investigate and to determine the most suitable and desirable shapes and forms for naval vessels, including aircraft.

The first buildings constructed at the activity included a linear interconnected complex of administration building, shop, laboratory building, and the David Taylor Model Basin. The DTMB Building was 1300 feet in length and was sited parallel to the other three structures. This structure housed a deep water basin, a shallow water and turning basin, and a high speed basin.

In the first year of operation at the DTMB work focused mostly on design. The model basin staff performed design work on battleships, submarines, destroyers, and other small crafts. It was not until World War II that research gained a significant place within the mission of the model basin.

During the war, the David Taylor Model Basin quickly was outfitted to undertake tests to seek solutions to specific war-related problems encountered by the fleet. Tests were performed to determine the characteristics of new ship designs, the hydrodynamic characteristics of torpedoes and depth charges, and the effects of structural modifications.

While the capabilities of the model basin were expanded during the war, unique testing facilities and equipment also were added to the installation. Constructed as a direct result of the programs assigned to the model basin, the new facilities increased the range of naval engineering research and testing able to be performed at the installation.[11]

In 1943, construction of a pentagonal test pond allowed for underwater testing of explosives. Small amounts of explosives in the test pond simulated the effects of full-scale underwater blasts on ships. With the ability to predict the effect of an underwater explosion, the Navy was able to construct ships and equipment that was tough enough to survive a wartime environment.[12]

The Circulating Water Channel, opened in 1944, allowed for the testing of water flow around ship and submarine hulls, torpedoes, and mines. Unlike the model basin, the Circulating Water Channel tested

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[10] Woolpert Consultants, Rhodeside & Harwell, Inc, "Master Plan Update, David Taylor Research Center" 1988 (Naval Surface Warfare Center, Bethesda, Maryland), 2.

[11] Navy Department, "David Taylor Model Basin History," 5.

[12] Bob Neil, "Carderock Naval Ship Research & Development Center," *All Hands* (Washington, D.C.: Government Printing Office, 1971), 6.

stationary objects while water, at varying speeds, moved past the test model. One advantage of a stationary model was that testing and underwater photographic observations could be performed for an indefinite period of time.

Introduction of Wind Tunnels at NSWC

By 1940, the wooden wind tunnels at the Washington Navy Yard were archaic and inadequate for needs of the rapidly advancing air fleet. Preliminary planning for modern wind tunnels begun as early as 1929 and then abandoned due to funding limitations. In 1940, work resumed on plans and specifications for improved wind tunnels.

As war approached, Congress recognized the need for new wind tunnels to support the Navy's aeronautic research program. Congress appropriated $500,000 on March 17, 1941 to construct a new wind tunnel at Carderock, Maryland. The initial design of the wind tunnels began in 1941 by the Bureau of Yards and Docks.

In February 1942, construction of the new aerodynamic building began at Carderock, Maryland; it was completed in 1943. The new building included offices, a library, a model shop, and two subsonic wind tunnels. The two identical tunnels were of welded steel construction with 10-foot test sections. The only difference between the two was power. One tunnel was capable of reaching test speeds of 180 miles per hour while the other tunnel only reached 150 miles per hour.[13] Complete models with wing spans as wide as eight feet fit comfortably into the test chambers. In 1944, a large contingent of the wind tunnel staff from the Washington Navy Yard moved to the facilities at Carderock.

The addition of wind tunnels in 1942 fulfilled the mission of the installation in executing research, experimental, and test work, primarily for the Bureau of Ships and the Bureau of Aeronautics.[14] The design of the new wind tunnels was intended to be adapted to a variety of testing scenarios. The tunnels could accommodate a range of test speeds and had the ability to test a wide variety and size aircraft, ships, and components.[15] The wind tunnels were designed and used for testing and evaluating existing material rather than as a research operation.

Toward the end of World War II, the invention of the jet engine greatly increased the operational speeds of aircraft and high speed testing facilities were needed to solve the new problems that accompanied increased performance.[16] Two supersonic wind tunnels were installed to the Carderock facility in 1946. The tunnels were discovered in Koehl, Germany. The tunnels were dismantled and sent to Carderock in their entirety.

During the same period, a feasibility study was completed that demonstrated that the construction of larger wind tunnels could permit the accurate testing of complete aircraft models. Officials at Carderock recommended that a three-meter sonic wind tunnel, discovered in Ottobrun, Germany, be brought back to

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[13] John Washko, personal interview, 17 June 1996.

[14] Navy Department, "David Taylor Model Basin," 2.

[15] Fresh, *The Aerodynamics Laboratory (The First 50 Years)*, 20.

[16] Fresh, *The Aerodynamics Laboratory (The First 50 Years)*, 22.

the Aerodynamics Laboratory.[17] Reconstruction of the wind tunnel was proposed in stages. Subsequent studies indicated that the cost to overhaul the German motors and other equipment was greater than the cost for the purchase of an American-made system with twice the power. As a result, only those parts of the German system that could be easily shipped or that were hard to obtain in the United States were sent to Carderock.

Initially, the German bred three-meter wind tunnel was used for sonic testing; changes in wind tunnel design allowed for this facility to include transonic capabilities as well. The airflow within a test section of a transonic wind tunnel did not duplicate actual conditions; the pattern of airflow in the Mach 1 range was disturbed by the walls. In 1946, researchers at the NACA Aerodynamic Laboratory designed a slotted wall wind tunnel that closely duplicated free flight conditions. Since all supersonic aircraft flew briefly in the transonic range, research on the effects to aircraft in this range were critical in the development of faster fighter planes.[18]

Computers take Charge

The David Taylor Model Basin continued expanding in the late 1940s. The Model basin was extended nearly 2000 feet to its current length of 3200 feet, and new facilities and equipment were installed to enhance and improve the capacities for research. The nature of the research also changed dramatically. While a tradition of modeling research was well established at the installation, the creation of a computer facility, first with a Universal Automatic Computer (UNIVAC-A) in 1953, and the Livermore Atomic Research Computer (LARC) in 1960, led to a new department and new developments at DTMB. Established as the Applied Mathematics Laboratory in 1952, the UNIVAC facility was designed to conduct research and to apply high speed computer techniques to data analysis.[19] Within the next five years, the facility performed research in calculation, specific engineering research problems, and operation, maintenance and design for naval vehicles using the computer.

By the late 1950s, the range of work performed in the computer laboratory included horsepower calculations and propeller studies, as well as, anticipating blast effects on ship hulls and the effects of vibrations on structures. Scientists were also able to analyze the effects of rough water and open water conditions on naval vehicles. In the past, testing was limited to the regulated wave patterns. All of these complex problems, previously unapproachable due to extreme volume of computational problems involved, could now be dealt with on the computer. This new technology not only removed the physical impediments to analytic solutions, but also moved the model basin away from its traditional area of concern - model testing. In 1959, the mission of the installation was modified to include high speed computer services to the Bureau of Ships, its laboratories, and shipyards.

On March 31, 1967, the Marine Engineering Laboratory at Annapolis merged with the David Taylor Model Basin to form the David Taylor Naval Ship Research and Development Center. The Naval Surface Warfare Center Carderock Division was established in January 1992 under the U.S. Navy's Laboratory

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[17] Fresh, *The Aerodynamics Laboratory (The First 50 Years)*, 22.

[18] Harry A. Butowsky, "National Register of Historic Places Nomination Form, Eight-Foot High Speed Tunnel" (MSS, National Park Service, National Register of Historic Places, Washington, D.C. 1984).

[19] Conn, *David Taylor Model Basin, A Brief History*, 24.

Consolidation Plan. The division was formed by the merger of the David Taylor Research Center and the Naval Ship Systems Engineering Station, Philadelphia.

From the early beginnings of the David Taylor Model Basin through the technological expansion of World War II and into the Cold War Era, the facilities at NSWC Carderock Division have been a the lead activity in the U.S. Navy's research, development, testing, and evaluation center for naval vehicles. Working together to execute the installation's original mission, the component laboratories have conducted work connected with hull design for naval vessels, hydrodynamic and structural problems, underwater explosion and attack protection for submarines and surface vessels, and aircraft component technology.

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View southwest of Subsonic Wind Tunnel Building. 1943.

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View south of Transonic Wind Tunnel. 1946.

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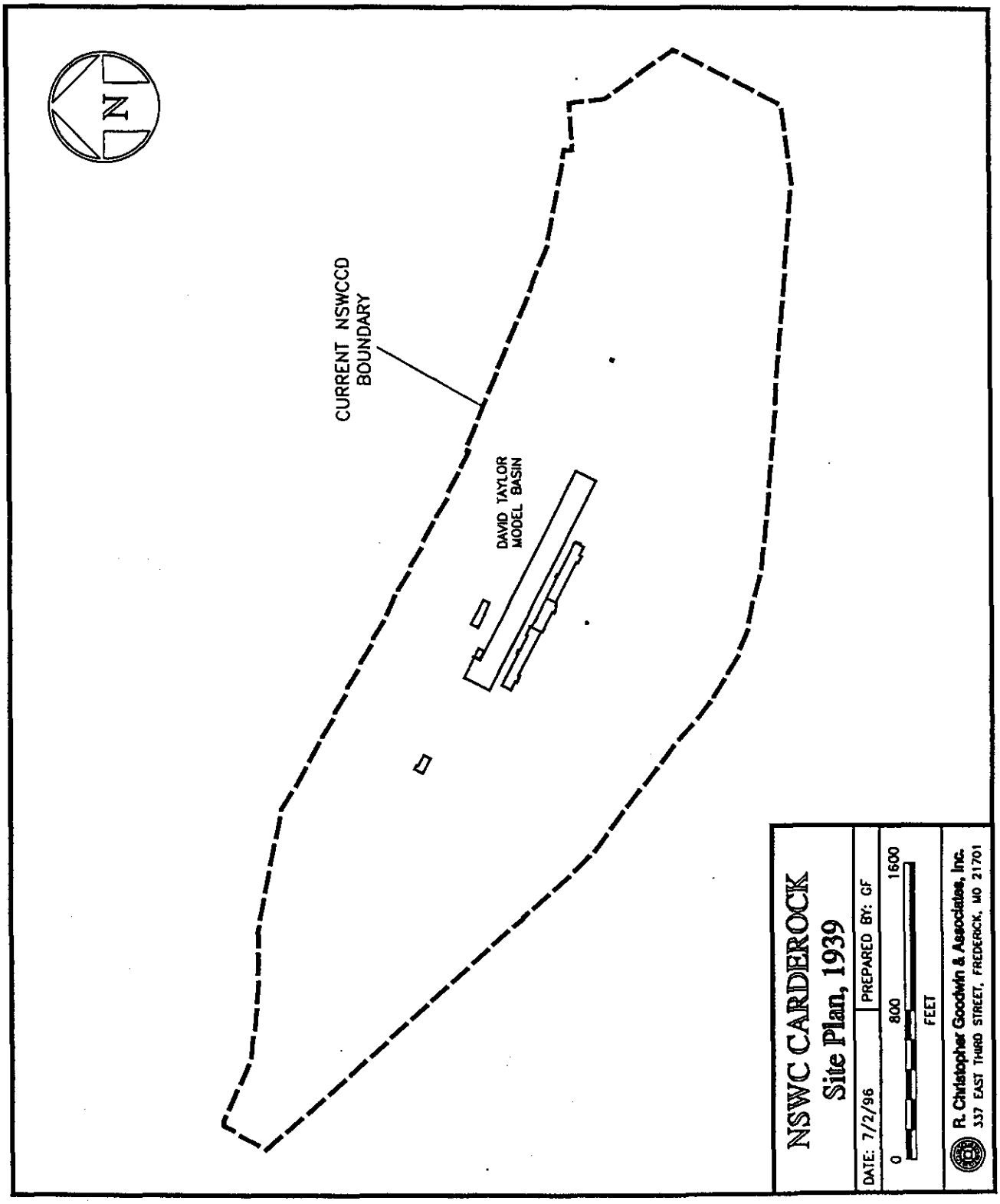
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Site Plan, 1939
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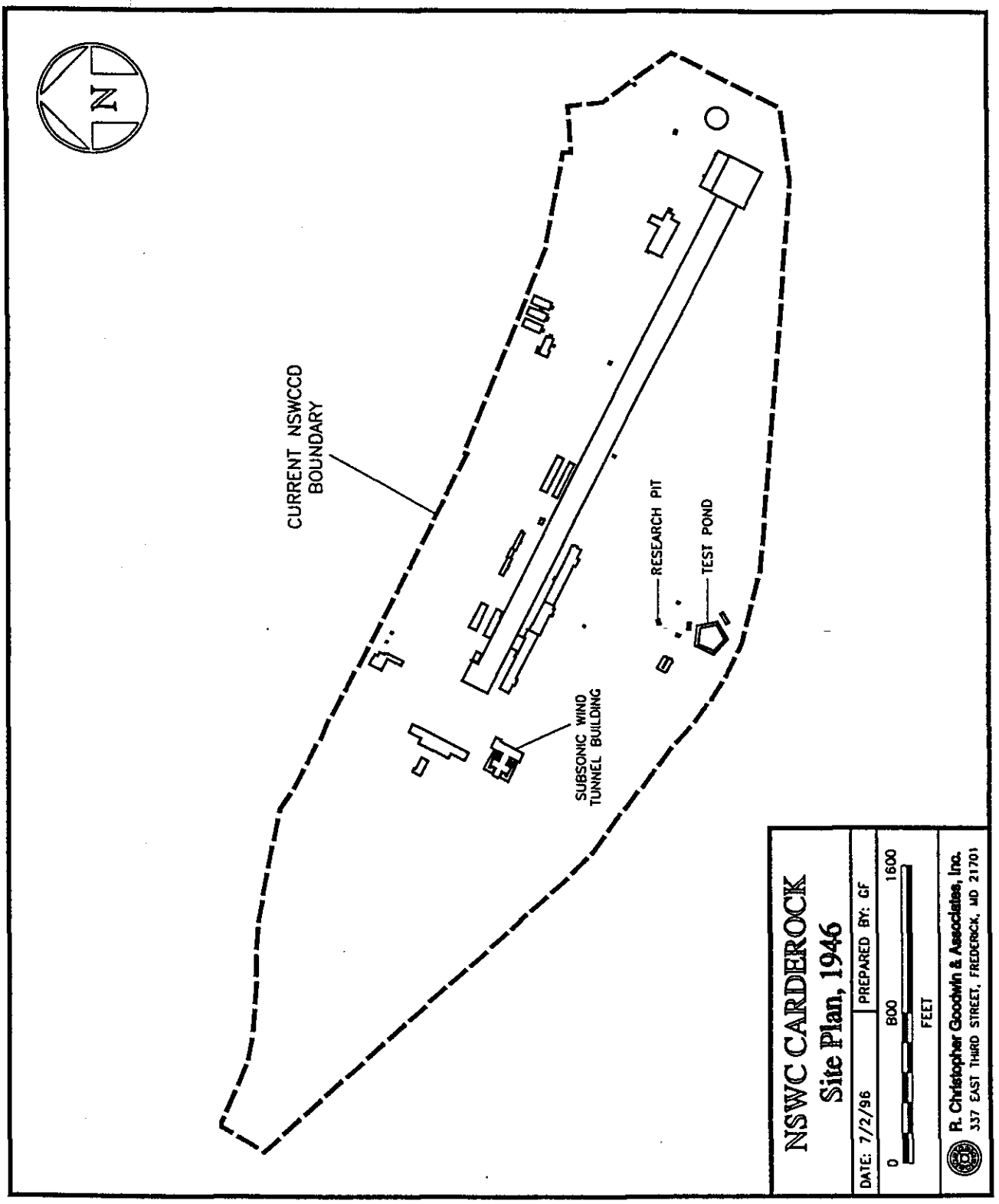
R. Christopher Goodwin & Associates, Inc.
337 EAST THIRD STREET, FREDERICK, MD 21701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NSWC CARDEROCK
Site Plan, 1946
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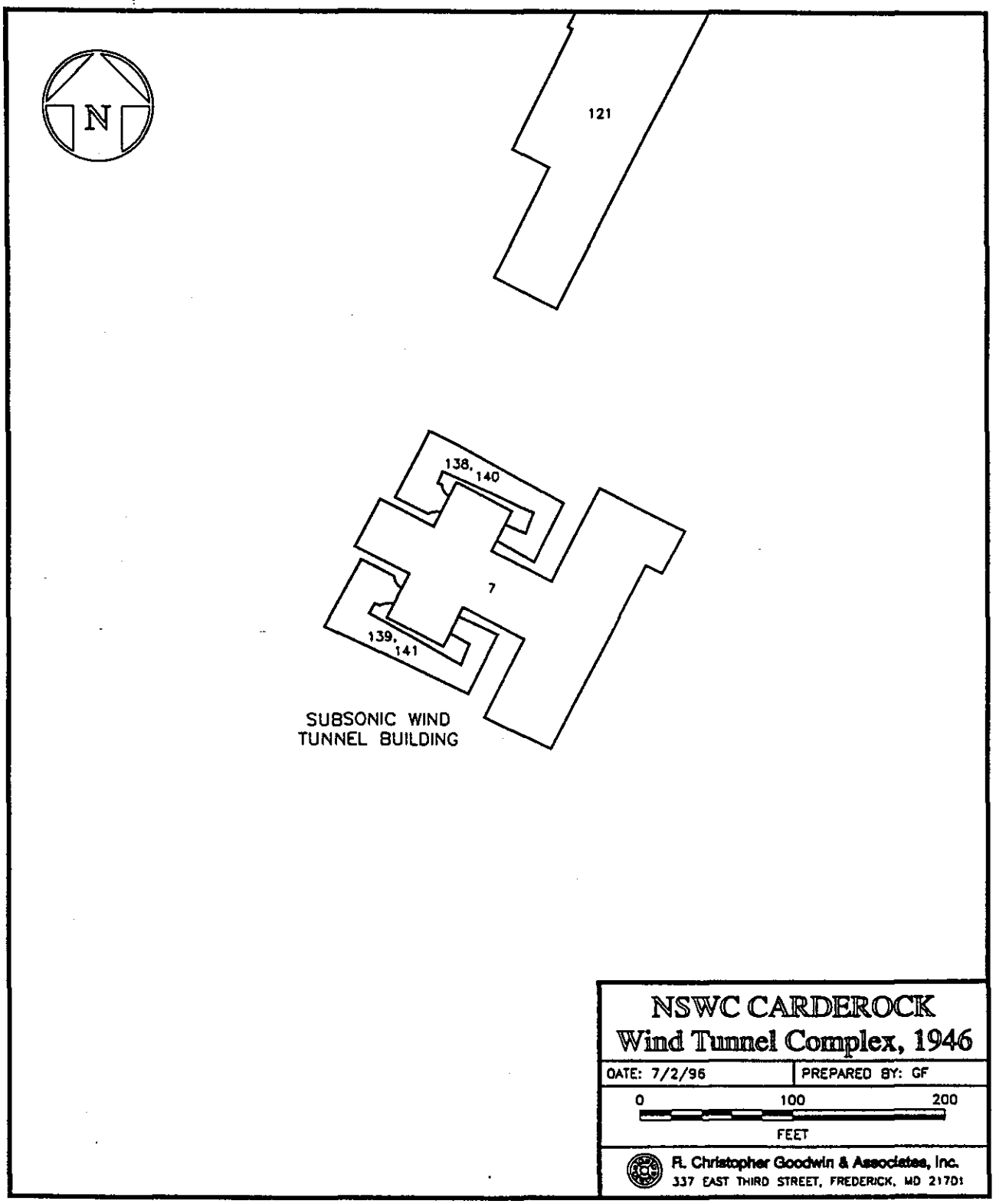
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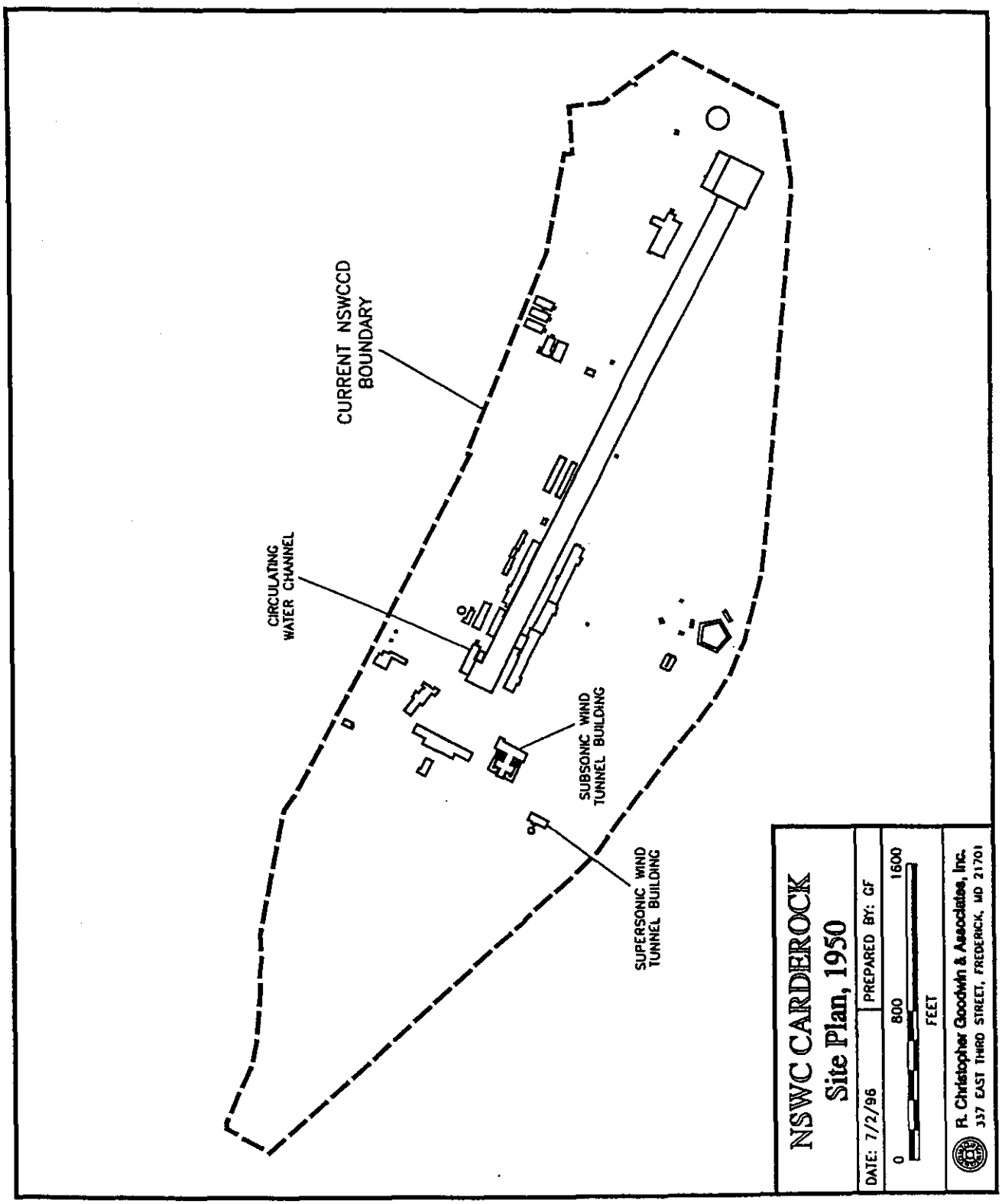
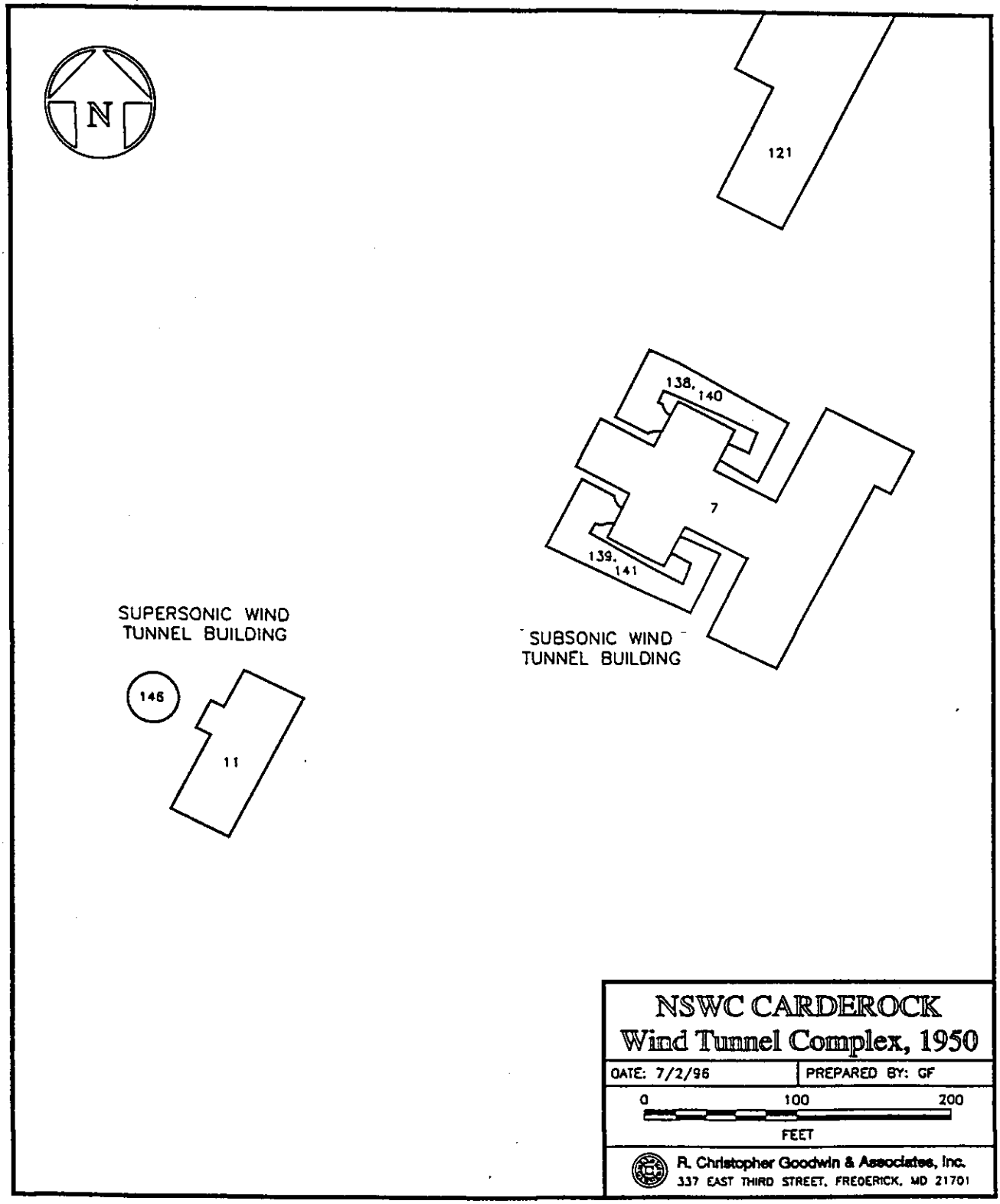

CURRENT NSWCCD BOUNDARY
CIRCULATING WATER CHANNEL
SUBSONIC WIND TUNNEL BUILDING
SUPERSONIC WIND TUNNEL BUILDING
NSWC CARDEROCK
Site Plan, 1950
DATE: 7/2/96
PREPARED BY: GF
0
800
1600
FEET
R. Christopher Goodwin & Associates, Inc.
337 EAST THIRD STREET, FREDERICK, MD 21701


N
121
138
140
7
139
141
SUBSONIC WIND TUNNEL BUILDING
SUPERSONIC WIND TUNNEL BUILDING
146
11
NSWC CARDEROCK
Wind Tunnel Complex, 1950
DATE: 7/2/96
PREPARED BY: GF
0
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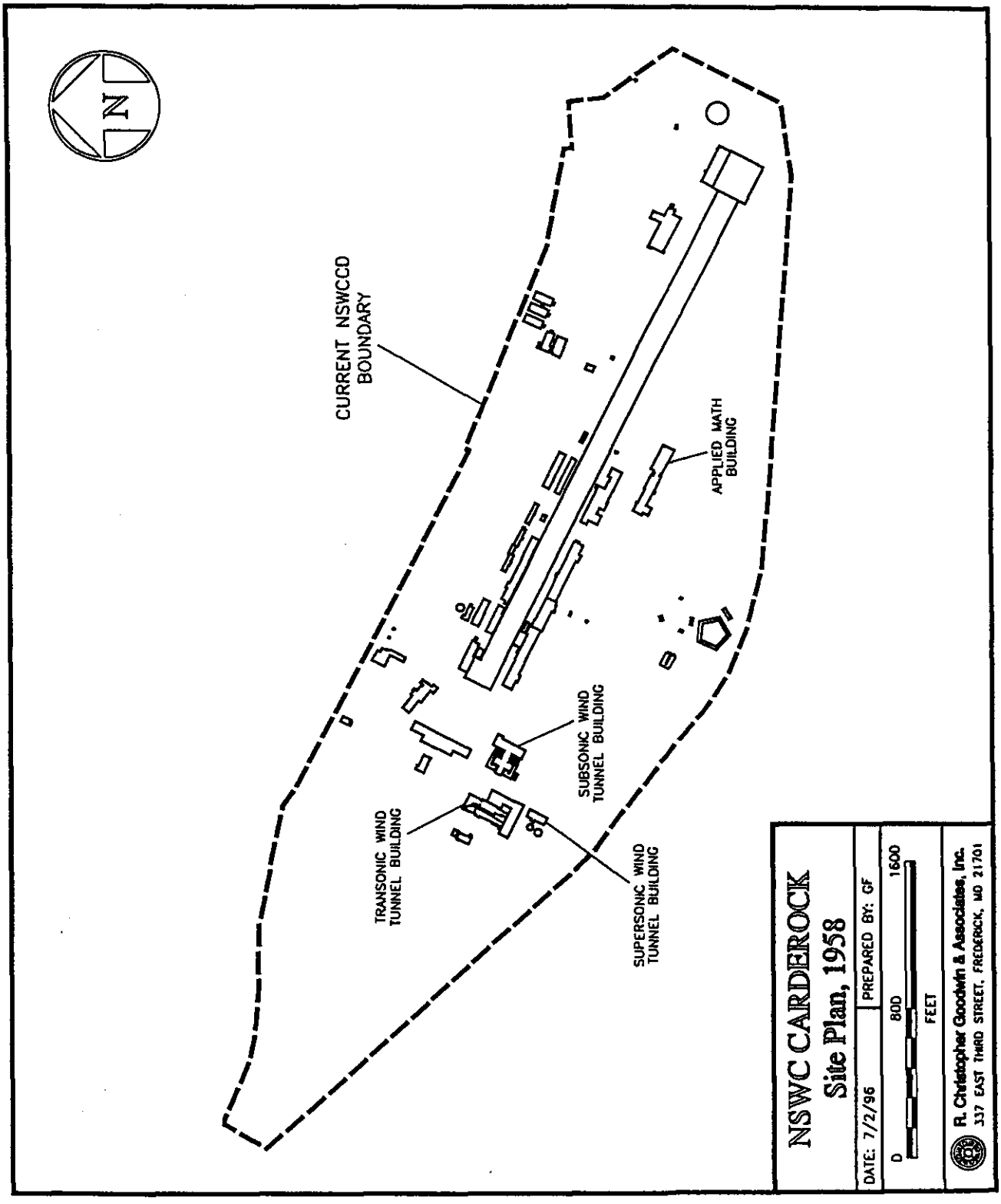
200
FEET
R. Christopher Goodwin & Associates, Inc.
337 EAST THIRD STREET, FREDERICK, MD 21701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CURRENT NSWCCD BOUNDARY
APPLIED MATH BUILDING
SUBSONIC WIND TUNNEL BUILDING
TRANSONIC WIND TUNNEL BUILDING
SUPERSONIC WIND TUNNEL BUILDING
NSWC CARDEROCK
Site Plan, 1958
DATE: 7/2/96
PREPARED BY: GF
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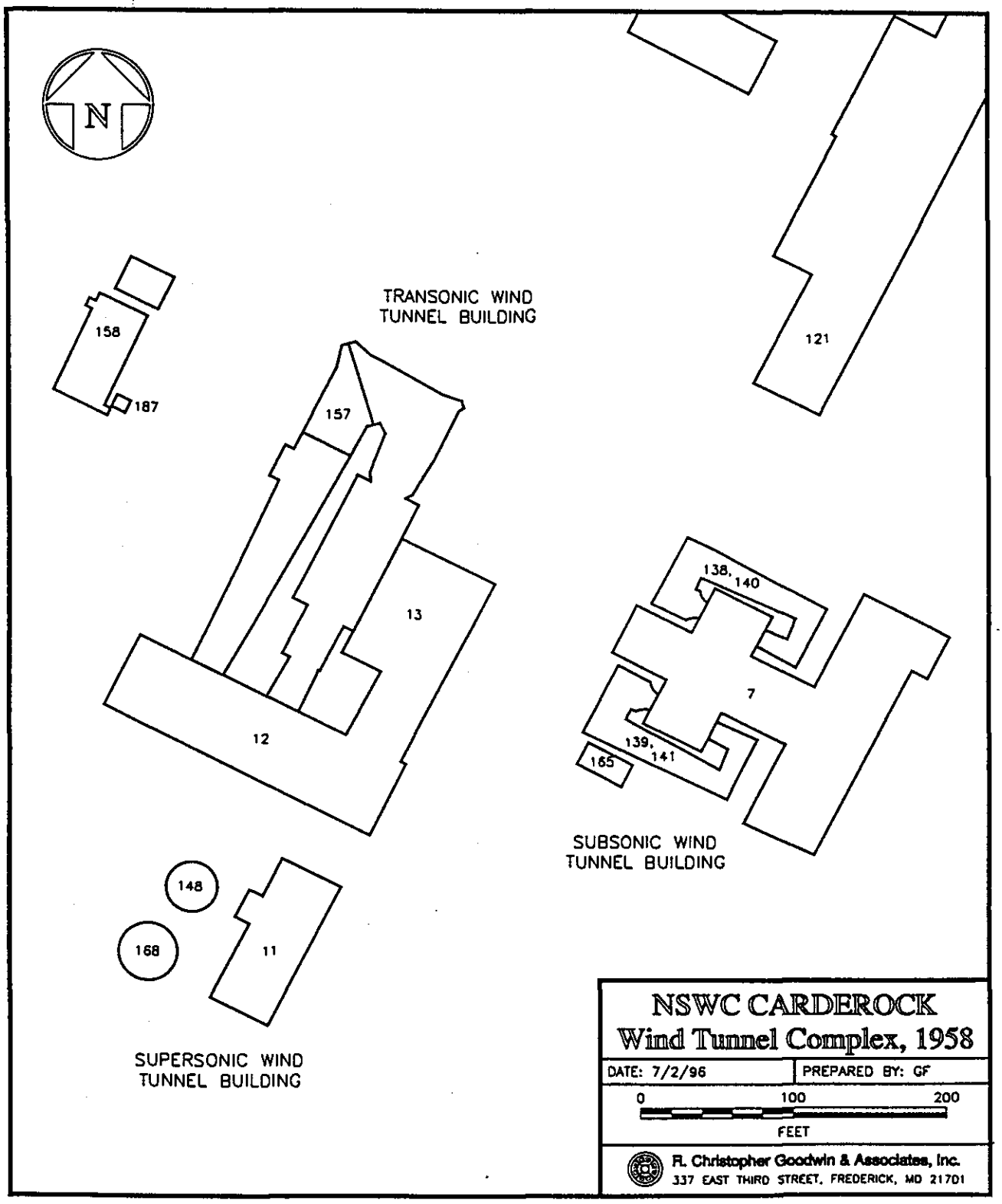
1600
FEET
R. Christopher Goodwin & Associates, Inc.
337 EAST THIRD STREET, FREDERICK, MD 21701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158
187
TRANSONIC WIND
TUNNEL BUILDING
157
13
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165
SUBSONIC WIND
TUNNEL BUILDING
148
168
11
SUPERSONIC WIND
TUNNEL BUILDING
NSWC CARDEROCK
Wind Tunnel Complex, 1958
DATE: 7/2/96
PREPARED BY: GF
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100
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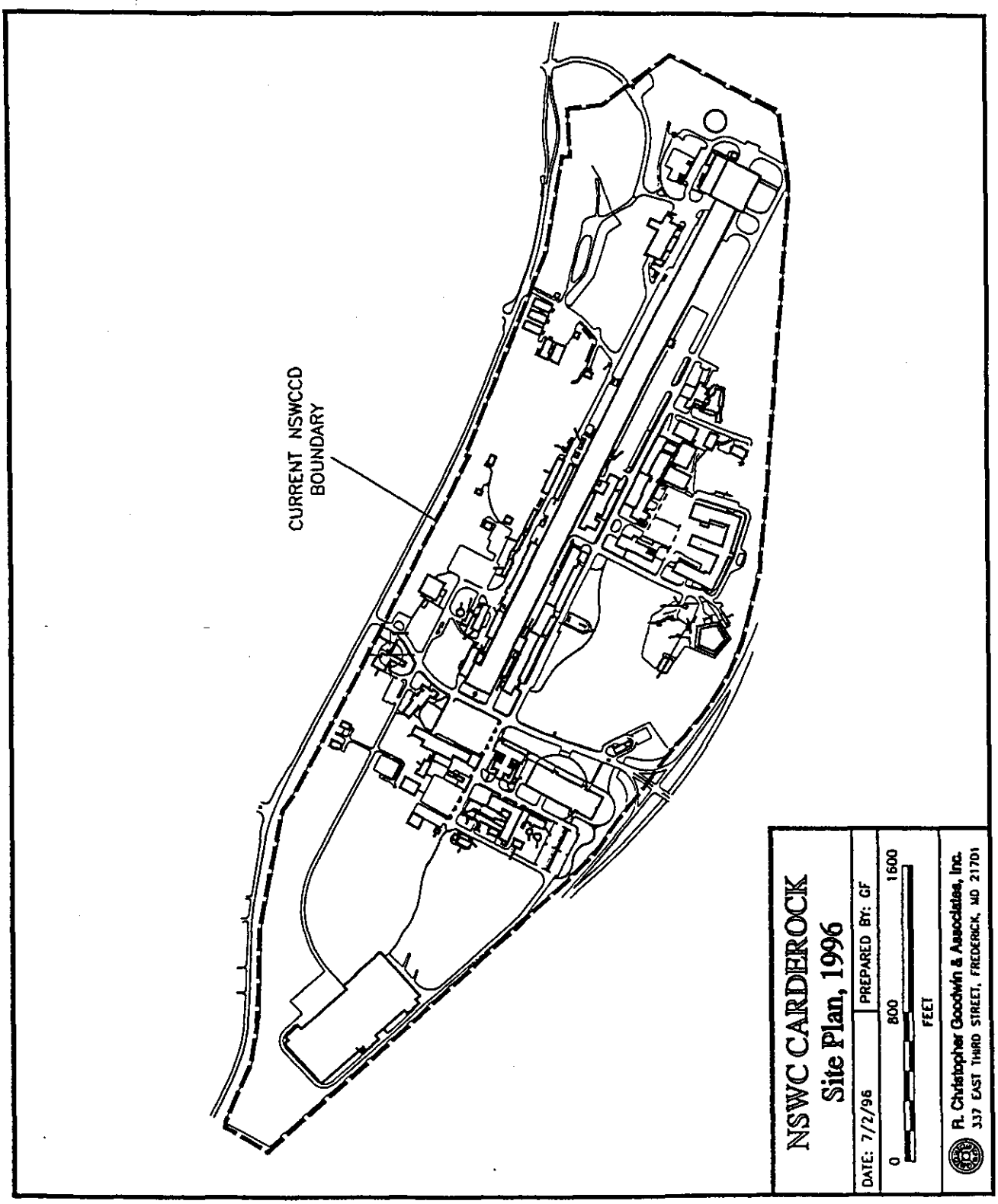
FEET
R. Christopher Goodwin & Associates, Inc.
337 EAST THIRD STREET, FREDERICK, MD 21701


CURRENT NSWCCD
BOUNDARY
NSWC CARDEROCK
Site Plan, 1996
DATE: 7/2/96
PREPARED BY: GF
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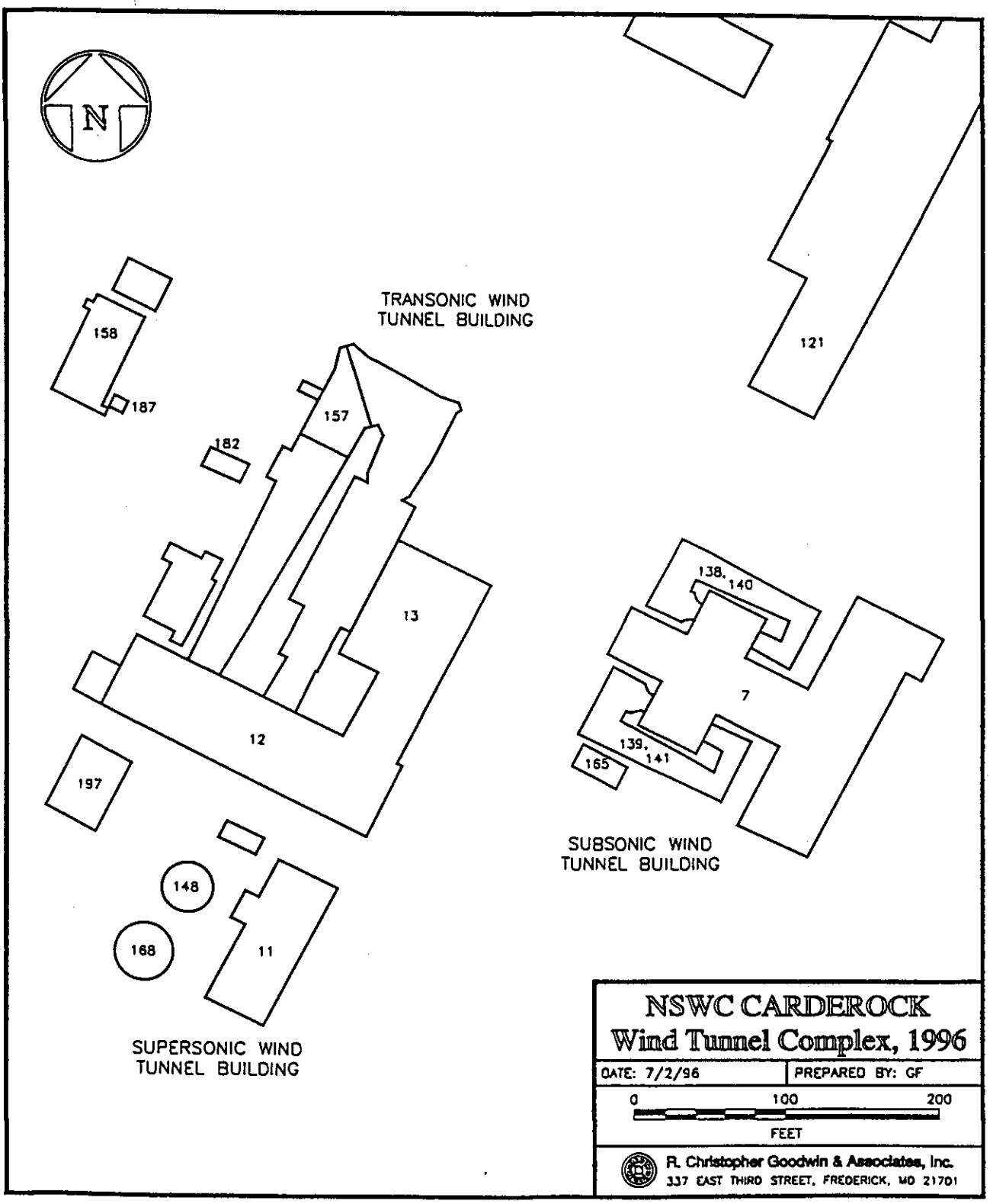
1600
FEET
R. Christopher Goodwin & Associates, Inc.
337 EAST THIRD STREET, FREDERICK, MD 21701


N
TRANSONIC WIND
TUNNEL BUILDING
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165
SUBSONIC WIND
TUNNEL BUILDING
148
168
11
SUPERSONIC WIND
TUNNEL BUILDING
NSWC CARDEROCK
Wind Tunnel Complex, 1996
DATE: 7/2/96
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